STANDARDS FOR REFRIGERATED APPLE STORAGES

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STANDARDS FOR REFRIGERATED APPLE STORAGES

Storage Temperature Held at 30° F. or Above; Storage Not in Use During the Summer Months.

Donald Comin[1]

I Building

Insulation

1. It is customary to provide 4 inches of corkboard or its equivalent for refrigerated apple storages. Properly installed and vapor-proofed non-board type insulations have performed as well as corkboard in many instances. Because loose-fill type insulations are generally cheaper than corkboard, and to compensate for any possible reduction in their efficiency from whatever cause, it is economical to use 50 percent greater thickness of this type of insulation than of corkboard (6 inches in walls).

Provision should be made for adding insulation to that in the walls in case of any settling. The loose-fill insulation in the ceiling is made continuous with that in the walls so that heat or cold will not enter too rapidly at the wall-ceiling junction at the plate. In the west and where the air is relatively dry,wood shavings are commonly used. Their low cost justifies the use of 10 to 20 inches or more instead of 6 inches.

2. Ceilings, due to the greater temperature differential across the ceiling than across the walls, require 5 inches of board-type insulation or its equivalent.

3. Floors, due to relatively low soil temperatures (50 - 55° F.), require only 3 inches of board-type insulation or its equivalent. Where floors are not

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directly on the ground, they require the same thickness of insulation as is used in the walls (see discussion on floors for detailed information of various methods of insulation).

Vapor Barriers

1. Insulation must be kept dry since water is a good conductor of heat and thus reduces the efficiency of insulation.

2. Water vapor almost invariably moves from the warm to the cold side of insulated areas such as walls, ceilings, etc. This is due to the fact that temperature affects vapor pressure to a greater extent than does relative humidity and the higher the temperature the higher the vapor pressure, other things being equal.

3. There is a reversal of direction of vapor movement through storage walls whenever the outdoor temperature falls below the storage temperature. Usually the average monthly air temperature in most of the northern United States is below 30° F. only during a few winter months (December, January, and February). Fortunately, the vapor pressures during these months are only slightly below that inside the storage and thus little moisture moves into the insulation from the inside. For this reason the vapor barrier is always placed on the outside of the storage insulation.

4. Vapor barriers should always be installed on the warm side (outside or inside of the outside walls) of insulation and no vapor barriers should be used on the cold side (inside of storage insulatinn) so as to permit any moisture (no perfect vapor seal is known) entering the warm side to pass on through and out the cold side to the cooling coils.

5. It is, therefore, recommended that a vapor barrier be placed on the outside or inside of outside walls; on top of ceiling insulation and under insulated floors for all refrigerated storages. (See exceptions pg. 5). Since vapor seals are inexpensive, their use is good economy and insurance for any storage. They also

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help to reduce infiltration of air into a storage during the warm months.

6. Vapor proof building papers should be asphalt impregnated, coated and glossy surfaced and should weigh at least 35 pounds per 500-foot roll. Saturated and coated felts (roll roofings) weighing not less than 125-pounds per 500-square-foot roll are also good vapor seals.

7. When conventional frame wall construction is used, one layer of vapor proofing paper may be installed between the siding and the sheathing and a second layer of the same paper placed on the interior side of the sheathing against the studs. If only siding is to be used, two layers of the paper should be used against the studs. The paper should be applied in the direction of the studs or joists and all joints broken, lapped 6 inches and cemented. Headers should be used between studs and joists when it is necessary to join two lengths of the paper. Galvanized nails may be used and their heads cemented over with vapor proof paint. For a still better seal, the studs, joists, or other construction into which nails are to be driven through the paper barrier may be coated with plastic roof cement. This helps seal the puncture in the membrane made by the nail.

8. The two layers of vapor proof paper should be applied on top of the ceiling joists, either between sub-floor and wearing floor or directly on the joists when a single layer of boards is used as a floor. Plain building paper (not vapor proof)such as Slater's Felt, may be used on the storage room side, that is, on the bottom side of the joists if necessary to confine the loose-fill insulation between the joists.

Some authorities suggest that if the insulation in the ceiling is exposed to a well ventilated attic or loft, no vapor barrier is required. Loose boards for a floor may be laid over the insulation.

9. All interior surfaces of outside masonry walls, concrete sub-floors upon which insulation is to be placed, and the top side of masonry ceilings should

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first be given a prime coat of asphalt to seal the surface. Paints or asphalts should be of approved type, having known vapor resistant properties, low melting points, and should be odorless after drying, incapable of softening or gelatinizing in water after drying and have no tendency to sag or crack.

There are two accepted methods of further sealing masonry construction. Over the asphalt coated surfaces may be cemented two layers of vapor proof paper having the joints broken, lapped and cemented as outlined above. This method requires that all rough surfaces, such as walls with mortar joints, must first be coated with portland cement plaster to provide a smooth surface for application of vapor barriers.

The second method requires only asphalt of a grade that will not shrink and crack after installation. First, all surfaces should be primed with a brush coat of asphalt emulsion of approved type at the rate of $1\frac{1}{2}$ gallons per 100 square feet of surface. After the prime coat has dried thoroughly, a mastic trowel coat of asbestos fibrated emulsion of approved type should be applied to a minumum thickness of 1/8 inch. This mastic coating should require at least 12 gallons per 100 square feet of smooth surface.

Brush coats (two) alone are also considered satisfactory by authorities. Two coats of aluminum paint on a smooth surface (no suction) is also accepted as an excellent vapor seal. In dryer climates, as in the West, vapor sealing is of much less importance.

Wall Construction

1. Frame wall or masonry construction is acceptable. Where masonry units are used, two 4-inch walls tied together with 6 inches of insulation between constitutes a load-bearing wall. In this type of construction joists should bear on the two walls unless they bear on beams placed at right angles to the walls. For two-story storages or those over 14 feet in height, an 8-inch outside load-bearing wall

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should be used or two 6-inch walls tied together. The portion of such walls below grade should be water proofed on the outside with tar or asphalt. This portion of the wall must be of ample strength to withstand the inward pressure of the earth. It is recommended that under all conditions a drainage tile line be placed around the footer on the outside to carry away any water which may reach the building foundation. The vapor seal may be placed on either side of the outside wall.

Pillars at the side walls to support ceiling beams or trusses seem advisable. Steel H columns in the inside wall or masonry pilasters built into and outward from the outer wall unit are recommended.

When the two masonry walls are laid up simultaneously, it is necessary to mop on the asphalt vapor seal on the inside of the outside wall as the sections of the two walls are being laid. In this way the masons scaffolding may be used while it is in place for their use.

Doors

1. Keep the number of doors to a minimum.

2. The minimum size of insulated entrance doors should be 4 by 7 feet in order that grab-trucks may be used. Use angle iron and 12 gauge sheet iron for protection of door jambs. Use lapped canvas in doorway to conserve on refrigeration while loading. A 2 by 2-foot insulated refrigerator door set at roller-conveyor level, also conserves on refrigeration during loading and unloading periods.

Ceiling Construction

1. Ceilings require 20 to 25 percent more insulation than side walls.

2. Because the ceiling insulation should be vented to the storage room, no tight seal is used on the lower side. Cement plaster, copper-bearing sheet metal, asbestos board, or redwood boards are suitable, providing the materials are matched or butted at all joints but not sealed. The flooring boards above should be spaced

sufficiently to permit ventilation of the insulation to the loft or sealed with vapor-proof paper if the floor is to be tight (tongue and grooved).

3. Beam supports for joists should not be placed below the joists unless the direction of air movement from the cooling system is parallel with such beams. If some types of trusses are used, no center supporting posts will be necessary. Steel I beam supports for joists will eliminate the necessity of having the beam extending below the bottom of the joists.

4. The insulation should be continuous from walls to ceiling, thus eliminating a poorly insulated junction between wall and ceiling. It is also advisable to make provision for adding more loose-fill insulation at the top of the wall should settling be encountered.

Floor Construction

1. Floors for 10 and 12 foot clearances must be designed to support 210 and 260 pounds per square foot, respectively.

2. Insulating the floor will reduce by 20 to 30 percent the capacity of the refrigeration unit required for a one story 10,000 bushel storage with a non-insulated floor. Stated in another way, two to three times as much refrigeration is required to absorb the heat leakage into the storage when the floor is not insulated than when it is adequately insulated. The advantages of insulated floors are naturally not so great for two-story storages.

3. Floors require 3 inches of corkboard or its equivalent. Four inches of cork is favored by some authorities. Where the floor is not laid on the ground, the same thickness of insulation used in the walls is required.

4. When corkboard is used it must be laid on a 3-inch concrete base in asphalt mopped on the concrete surface. Two layers of $1\frac{1}{2}$ inch corkboard or a 2-and a 1-inch layer are used in order that the joints of the first or lower layer may be

overlapped by the second cork layer. Asphalt is mopped on the first layer of cork before the second layer is applied and on top of the cork before the concrete wearing surface is applied.

5. To reduce costs of floor insulation installed, vermiculite (expanded mica) $6\frac{1}{2}$ inches; sawdust, $7\frac{1}{2}$ inches, or regranulated cork, 7 inches, may be used mixed with cement. The vermiculite (waterproofed with a resin) concrete requires 1 bag of cement, 8 cubic feet of vermiculite aggregate and 26 gallons of water. These quantities, if multiplied by 3.4 will produce 1 cubic yard of finished insulating water-repellent concrete or approximately 325 board feet. The cement-vermiculite ratio by volume is 1 to 8; its ultimate compressive strength in pounds per square inch is 70; its density is 22 pounds per cubic foot; and its thermal conductivity (K) is 0.6.

The sawdust cement is made of 1 bag of cement, $3\frac{1}{2}$ cubic feet of non-fresh, first-saw sawdust and 5 to 10 gallons of water. These quantities if multiplied by 8 1/3 will produce 1 cubic yard of finished insulating but not water-repellent concrete or approximately 325 board feet. The cement-sawdust ratio by volume (loose measure) is 1 to $3\frac{1}{2}$, its ultimate compressive strength is 300 to 400 pounds per square inch; its density is 45 pounds per cubic foot; and its thermal conductivity (K) is said to be 0.6 to 0.7.

It is suggested that ground or fine regranulated cork might be used as an aggregate in a similar manner to that of vermiculite or sawdust, although no experimental data on its use is available. Also water-proofing admixes need to be developed for sawdust and cork insulating concretes.

These mixtures are applied on top of a 3-inch concrete base which has been previously vapor proofed by mopping asphalt on its surface. They are then covered with a 2 to 3-inch layer of topping cement for a wearing surface using the proportions of 1 bag of cement, 1 cubic foot of sand, 2 cubic feet of coarse aggregate, and 5

gallons of water.

6. Where it is known that the earth will remain bone dry, it is suggested that the area be leveled and tamped, covered with two layers of vapor-seal paper mentioned on page 7 (with all joints well mopped with asphalt) and covered with the insulating concrete as suggested on previous page. No vapor seal should be used above the insulating concrete.

7. A somewhat less expensive and easier method of laying an insulated floor which makes use of the maximum insulating value of loose-fills is to place small blocks of tile with the opening in a vertical direction on approximately 3 foot centers in two directions on the concrete sub-floor and fill between the tiles and in the center of the tiles with a loose-fill insulation. Light weight aggregate cement blocks or blocks made of vermiculite and cement could also be used. After filling in with loose-fill insulation to the top of the blocks (height previously chosen) the area should be covered with a water-proof but not vapor-proof paper or for greater strength a layer of welded wire mesh might be used to support the paper. Wire mesh with a paper backing attached is available. Upon the paper should be poured a thin (1-inch) light coat of cement topping. After this initial layer is set, the remainder of the 3-inch topping cement may be poured.

8. Twelve inches of cinders topped with cement has been suggested by some authorities as adequate for apple storages.

9. The base supports for pillars, columns, or posts in the interior of the storage room need not be insulated for the type of storage discussed here.

II Refrigeration

General--

1. Many farm storages in Ohio do not have adequate refrigeration capacity. It is recommended that with standard insulation (see above) farm storages should have 0.25 tons of refrigeration per 1000 bushels capacity to care for the heat leak into the storage during the warm loading-period.

2. There should be provided approximately 0.6 ton of refrigeration per 24 hours per 1000 bushels of storage capacity to absorb the field heat of the apples loading in storage at 10 percent of its holding capacity per day; at 7 percent loading rate, 0.4 should be provided; and at 5 percent loading rate, 0.3 tons should be provided. This is equivalent to cooling one crate or box of apples weighing 50 pounds through a range of $34\frac{1}{2}^{\circ}$ F. which is chosen as a standard. If the fruit is cooled through a greater or lesser range, the heat load would be correspondingly larger or smaller.

3. The heat generated by respiration of the fruit in storage must be taken into consideration. For loading rates of 10, 7 and 5 percent of storage capacity per day, 0.1 ton, 0.07 ton and 0.05 ton of refrigeration, respectively, should be supplied per 1000 bushel storage capacity.

This is equivalent to a peak respiration load the last day of loading of 90 BTU per crate or box of apples weighing 50 pounds loaded in storage the last day plus 22 BTU per crate or box already at storage room temperature. This respiration load is chosen as a standard and if the fruit was loaded more rapidly or the storage held above 40° F. during loading, the respiration heat load would be greater than given above.

4. The service heat load, such as heat intake through door openings, men working in storage, heat from motors, and lights in storage, is usually cared for by supplying additional refrigeration to the extent of 10 percent of the above three heat-loads combined.

5. The totals of the preceding heat-loads which may be used as approximate estimations of refrigeration required when loading storages at 10, 7, and 5 percent of their total capacities per day, are 1 ton, 3/4 ton, and 2/3 ton of refrigeration, respectively, per 1000 bushels capacity of the storage.

Compressors and Condensers

6. Suction or back pressures should be maintained at as high a level as possible. In order to insure that the suction pressures do not fall, suction-pressure control valves are highly recommended.

7. Evaporative or shower-type condensers are recommended for maintaining low head pressures and economizing on power, especially where water temperatures and pumping costs are high and where an ample water supply is not easily available.

8. All compressors should operate at the slowest speed specified for any given manufacturers model, for the longest life and power cost. It is expedient to increase the speed of compressors to secure additional refrigeration capacity during short periods of heavy loads such as when the storage is being loaded.

9. Two compressors are preferable to one of the same total capacity and are also considered superior to that of having one machine with a change of speed of operation. Dividing the total peak cooling-load into two-thirds and one-third for two-compressor installations is recommended. Unloaders and partial by-pass as a means of reducing compressor capacity may be used with the larger sizes when necessary.

10. The storage-room temperature should be controlled thermostatically to not more than a 2-degree range. The controls should be mounted on rigid supports to prevent their getting out of adjustment, and preferably in the return air steam close to the middle of the storage room.

Cooling Units or Diffusers--

1. Floor-mounted cooling units are more common, at least in storage rooms having capacities above 4000 bushels. The trend appears to be toward ceiling mounted units even in large rooms.

2. Ducts for air distribution in the storage are not required unless the air must travel more than 40 or 45 feet to reach the walls opposite the air discharge

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from the blower. Ducts do provide a somewhat better distribution of the refrigerated air, and they permit the control of the air flow to any portion of the storage. Air distribution through ducts prevents the short circuiting of a portion of the air directly back to the intake of the cooling unit before it has traveled through the stacks of crates. With ducts the air may be taken off the floor or ceiling, allowing for a reversal of the air flow when desired.

To facilitate air movement through the stacks, the stored product should not be stacked on floor strips; there should be a minimum of 12 inches between the tops of containers and the ceiling; a space of from 4 to 6 inches should exist between the containers and the wall opposite the unit, the rows of containers should be stacked with about 2 inches of space between adjacent ones. Furthermore, there should be no aisles or alleyways parallel to the direction of air flow, since they act as flues and reduce air circulation within the stacks. If it seems necessary to have such alleyways, curtains should be hung across them to prevent a flue action. Alleys at right angles to the direction of air flow may prevent good air movement in the rear of the room by permitting the air to short circuit. This can be remedied by bridging across the top of such an alley with wall boards or canvas. All exposed girders or beams should run parallel to the direction of air flow unless ducts are used.

3. There should be not less than 1000 cubic feet per minute of air circulated per ton of refrigeration, or the cubic feet per minute should be equivalent to, at least, one-third of the cubical content of the storage room, or the cubic feet per minute should be a figure equivalent to 85 percent of the storage capacity in terms of bushels.

4. The "split," or the amount of temperature reduction of the air in passing through the cooling unit, should not exceed 10° F. during the loading-in

period.(1) This means that the T. D. or temperature difference between the return air and the refrigerant or coil temperature (the basic rating of the coil in B.T.U. per hour times the T. D. gives the operating capacity of the coil) will be approximately 15° F. During the holding period the cooling load will be less and the "split" will automatically drop to 2° or less.

5. The fin spacing of the cooling coils should not be less than 3/8 inch, and preferably 1/2 inch. One-third inch or 3 fins per inch seems to be the most common spacing for coils in this type of installation.

6. Automatic off-cycle defrosting of the cooling coils is most satisfactory but requires large total coil area, wide spaced fins, back-pressure control valves, and a narrow T. D. or "split" with an average room air temperature not much below 34° F. It is not as reliable as water defrosting which can be made automatic by means of a time clock control. Water defrosting should not be required except during the loading and early storage period unless the storage temperature is held below 33° F.

7. When found necessary to increase the humidity in storages, some type of humidifier which will produce a fine mist, such as a pneumatic atomizer, should be used.

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(1) There is some divergence of opinion on the meaning of terms such as "split." Some authorities use the term "range" in place of "split," for the latter term is supposed to designate the temperature difference between discharge air and the coil. "T.D." is used to designate the temperature between the return air and the coil. Most coil manufacturers base their coil surface rating on T.D. although it may be on the basis of the mean temperature difference or M.T.D.

REFLECTIVE TYPE INSULATION

Since this mimeograph was initially revised, May 15, 1946, a new material and method of insulating fruit and vegetable storages has been introduced with considerable success. Basically the material is aluminum foil fabricated into various configurations so that more than one layer may be installed between studs, ceiling or floor joists and roof rafters at one time and as one unit. Reflective insulation employs an entirely different principle of resisting heat flow than has been associated with loose fill, bat, blanket and board types. Since 65 to 80 percent of the total heat flow through an uninsulated wall space is usually by radiation, reflective insulation, by stopping up to 97 percent of this radiant heat flow does an excellent job of slowing up heat movement into a storage. It also retards the flow of heat by conduction and convection but to a lesser extent than do the other insulation materials mentioned.

The advantages of reflective insulation over other types for insulating storages are several. The most important advantage is its low cost per unit of thermal resistance installed which is the only accurate way of comparing insulations. Naturally, it must have long affective life and be nearly indestructable from any cause. Reflective insulation is good from this standpoint if used in sufficient thickness and protected from rodents and damage by wind or man. Since moisture does not affect aluminum, vapor seals are not required and in fact this insulator is frequently used as a vapor seal in connection with other insulations. It may be installed by any careful worker after a little practice. Many of its other advantages are minor in comparison with those just mentioned and will not be discussed further here.

This material has several disadvantages. One of some importance is its deterioration when allowed to come in contact with several other common metals such as iron or copper in the presence of moisture. Although this insulation is commonly installed by means of coated staples, it is strongly advised that it be installed by

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the use of wood lath strips against the flanges using aluminum nails. Various metalic tapes with an adhesive are available for better sealing over the flanges. They are usually only used with low temperature installations. Since it is an excellent vapor seal, moisture may collect by condensation to the point where the weight may cause it to pull away from the fastenings used. This does not occur providing the spaces between the joists, studs or rafters are open to a well ventilated attic or crawl space. It would appear that the only place this moisture may cause trouble is between roof rafters on flat roofs for other types of roofs usually have some space above the collar beams (cap under the ridge) which is vented to the outdoors. This ventilation has little effect on increasing heat loss or gain. Walls seem to give no trouble in this respect because the moisture is continually driven out through the outside sheeting through natural diffusion to an area of lower vapor pressure or lower relative humidity. No records of paint failure from this moisture have been reported. It is because of the relatively tight (vapor seal) roof such as roll roofing that precautions must be followed when installing this material between flat-roof rafters. Providing aluminum of sufficient thickness is employed (.0007 of an inch) no other disadvantages are of sufficient importance to discuss here. Reports show that any moisture or dust collecting on this insulation alters its insulation value very slightly if at all.

Reflective insulation comes in many types and weights or thicknesses. It is laminated or attached to paper of varing weights and may carry several thicknesses for more insulation value. It may be accordion pleated with durable paper between layers of aluminum to increase its insulating value, or other means may be used to separate the several layers of aluminum foil. The various layers of foil should not face each other, but be separated by a non-reflecting material for highest efficiency. Nor should the layers of foil be allowed to touch each other or any other surface if they are to reflect heat. The thickness of the foil will vary with manufacturers

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and the thicker foils are to be preferred. Where the foil is to be left exposed to the storage it is customary to use a greater thickness than for the layers not exposed. An example might be .0007 inches for the unexposed layers and .0015 inches for the exposed layer. It must be protected from mechanical damage if this can occur.

Great detail is usually given by manufacturers in their directions for installing reflective insulation. It is sufficient to point out here that this insulation comes in various widths for flanging between studs, joists or rafters on different centers. The insulation flanges are made thick and usually strengthened by compressing the many layers of foil and paper. They may be tacked together to allow several widths of material to be used in bridging unusually wide spaces such as between metal joists, beams or trusses. If the insulation is to be left exposed in the storage the flanges may be lapped on the edges of the studs or joists to provide a continuous foil layer over the wood. This insulation may be installed anywhere in a storage including the floor where a concrete wearing surface may be applied on the floor deck resting on sleepers. If the insulation is to be left exposed in the storage, slatting must be installed at least on the lower portion of the walls in order to protect the foil from crate damage.

When applying this insulation to concrete block or tile walls it is customary to erect studs or furring strips on the walls and flange the insulation between. This material comes in compressed rolls or strips occupying very much less space than comparable insulation of other types. It is much lighter in weight than other forms and has much less heat capacity, that is, cools down rapidly and holds little heat from daytime absorption. It comes in rolls 100 or more feet long and may be cut with shears for fitting from floor to ceiling or from wall to wall. Its ease of fitting into odd spaces and around timbers makes it very useful in insulating existing buildings such as old barns and barn basements in adapting them for fruit storages.

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Although the insulation value of foils varies somewhat, an example will suffice to indicate its value. A single layer* might be equivalent to 1-4/5 inches of rock wool, two layers 3-3/4 inches and three layers 5-5/8 inches of the same material. It must be pointed out that unlike other types of insulation, reflective insulation stops more heat on down flow than up flow by roughly 50 percent. This is due to the factor of heat movement by convection which is absent on down flow of heat. Thus this is important in insulation in ceilings and floors. In refrigerated storages where most insulations are increased by 25 percent in ceilings, the same thickness of reflective insulation is used in both ceilings and walls.

Costs of reflective insulations are quite variable since they vary in thickness of foil and methods and materials of fabrication. The thicker foils are apt to be free of pin holes characteristic of very thin foils and they possess greater bursting and tearing strength. Good reflective insulations will cost approximately 10 to 12 cents per square foot for 3-foil material, the minimum thickness recommended for apple storages. The cost of instalation depends on many factors, but usually falls between 1 to 3 cents per square foot.

It should be pointed out that since the use of reflective insulation in apple storages is relatively new, much is yet to be learned through experience. Likewise, many improvements in the manufactured products and in their use will undoubtedly be made. At present reflective insulation of proper thickness and properly installed offers a promising method of insulating apple storages based on cost, performance, and the specific requirements of the farm Refrigerated Apple storage.

It might be well to point out that much thicker Aluminum sheets (.006 inch) are available in rolls for insulating storages where greater initial costs are warranted. This material has the advantage over thinner foils of not pin holeing when

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* Based on published data in "Thermal Conductivity Tests and Results." E. A. Allcut, School of Engineering Research, University of Toronto. 1949.

creased, in fact, it is not creased since it is not folded, but installed in single parallel layers with furring strips between each layer. The great advantage of this type of material and installation is the reduction of infiltration of air to practically zero. Likewise, the vapor or gas tightness of the room is excellent. This is in contrast to the folded-then expanded foils which require careful installation with furring strips and possibly adhesive tapes or coatings to insure against warm air infiltration. In view of this consideration some authorities favor the use of loose-fills in conjunction with the newer vapor and infiltration sealing materials which transmit zero moisture vapor on test. This allows the use of relatively cheap fills because they are maintained in a dry condition and, therefore, continue to maintain their insulating efficiency over long periods of time.

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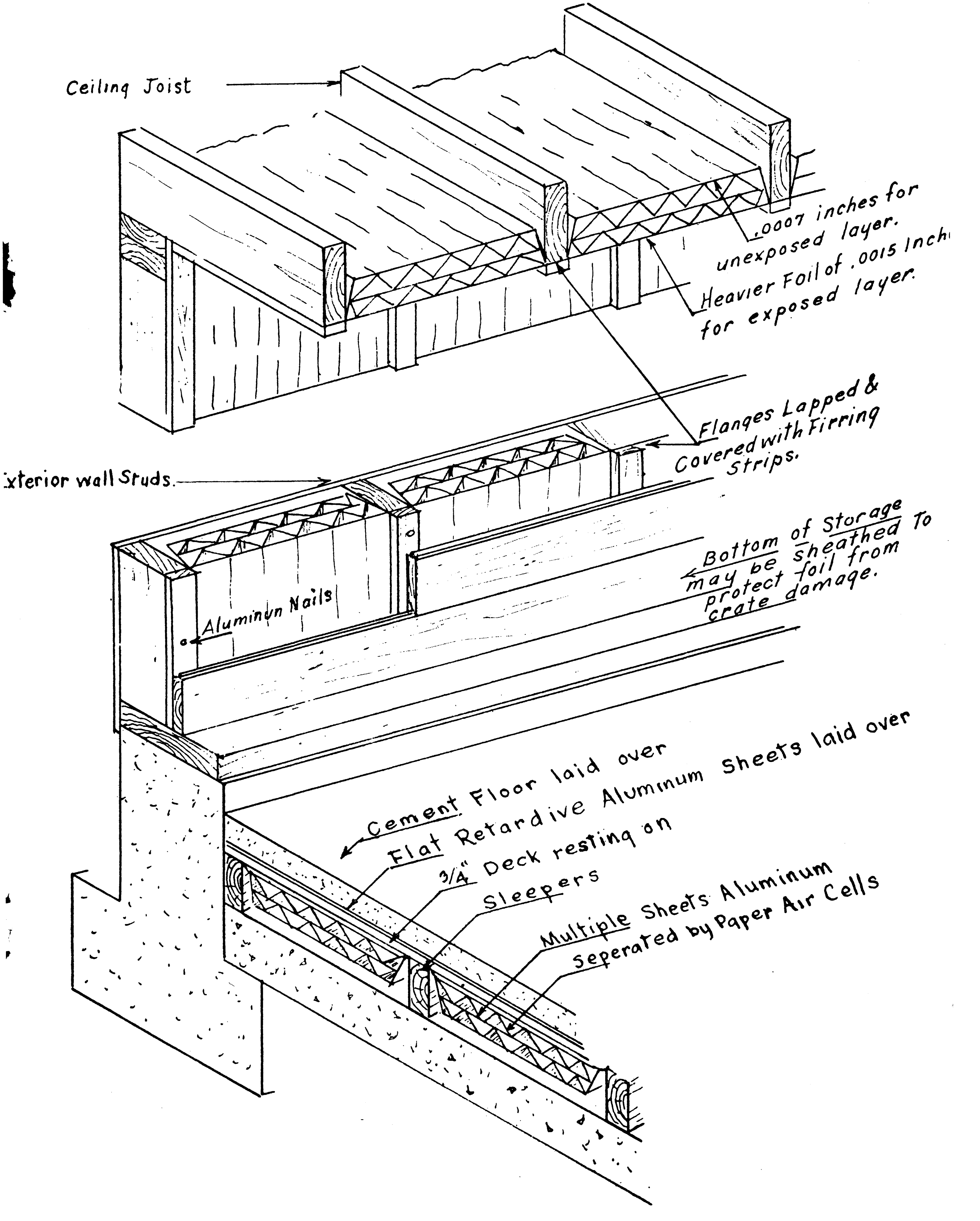

Ceiling Joist
.0007 inches for
unexposed layer.
Heavier Foil of .0015 Inch
for exposed layer.
Flanges Lapped &
Covered with Firring
Strips.
Exterior wall Studs.
Bottom of Storage
may be sheathed To
protect foil from
crate damage.
Aluminum Nails
Cement Floor laid over
Flat Retardive Aluminum Sheets laid over
3/4" Deck resting on
Sleepers
Multiple Sheets Aluminum
Seperated by Paper Air Cells

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